Enhanced Position Location Reporting System: Legacy System Provides New Technology for Warfighters

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ABSTRACT

The Enhanced Position Location Reporting System (EPLRS) originated more than 30 years ago during the Vietnam conflict as a system to prevent troop casualties due to "friendly fire," or "fratricide." The initial system, the Position Location Reporting System (PLRS), focused primarily on providing Position Location Information (PLI), identification, and navigation aides to the warfighter. This information was collected and (after processing) distributed by a simple but effective network of Radio Sets (RSs). The latest generation of Enhanced PLRS (EPLRS) retains the PLI, identification, and navigation capabilities of PLRS but incorporates the newest and most sophisticated technology into the communications network. The RSs provide high-data-rate (HDR) communications and real-time routing capability. Each RS incorporates an embedded router that enables contention-free routing of data between communications services and makes one RS look like many radios (up to 32) to host equipment. A newly developed computer program, the EPLRS Network Manager (ENM), which resides in a laptop computer, manages the RS network. The ENM provides distributed network management to the RSs that includes network planning, communication circuit information, system monitoring, fault detection and resolution, continuity of operations, and key management.

INTRODUCTION

The Position Location Reporting System (PLRS) and its successor, the Enhanced Position Location Reporting System (EPLRS), were initiated during the later stages of the Vietnam conflict. PLRS was developed by the Marine Corps as a system to prevent troop casualties due to "friendly fire" or "fratricide." The Army, building on the PLRS technology, initiated EPLRS to provide more advanced communications capabilities. The Navy adopted PLRS and later EPLRS to provide communications and position location information in conjunction with the AN/KSQ-1 Amphibious Assault Direction System (AADS) installed on many amphibious ships.

EPLRS serves all three services as a position location, identification, communications, and (sometimes) navigation system that incorporates the newest and most sophisticated technology. Two versions of EPLRS are currently in service. They each consist of two primary components, a network control element and a network of Radio Sets (RSs), as shown in Figure 1. The older version of EPLRS includes a Network Control Station (NCS), which has been replaced in the latest generation of EPLRS by an EPLRS Network Manager (ENM).

Both versions of EPLRS have similar capabilities but have some significant differences. The two systems are not compatible, primarily because of changes made in the RS firmware. Additionally, some of the functions performed by the NCS have been allocated to the newer version of the radio (e.g., position calculation and distribution). Other NCS functions (i.e., generation of Navaids and Situation Display) are expected to be accomplished by the services' host computer systems, such as the Army's Force Battle Command Brigade and Below (FBCB2) system and the Marine Corps Command and Control Personal Computer (C2PC) system. Both versions of EPLRS provide important capabilities for the warrior. However, unless otherwise indicated, the information presented in this paper applies mainly to the ENM version of EPLRS.

The latest generation of EPLRS features a network of highly sophisticated RSs that provide high-data-rate (HDR) communications and real-time routing capability. Each RS now incorporates an embedded router that enables contention-free routing of data between communications services and makes one RS look like many radios (up to 32) to host equipment. The ENM provides distributed network management to the RSs that includes network planning, communication circuit information, system

monitoring, fault detection and resolution, continuity of operations, and key management. ENM consists of an operator workstation and associated communications and support equipment.

FIGURE 1. EPLRS radio.

BASIC CHARACTERISTICS AND CAPABILITIES

The EPLRS network consists of many EPLRS RSs and one or more ENM host computers. The RSs automatically route and deliver user messages and provide multiple concurrent communication paths known as "needlines." The host computer may be an ENM computer or another type of user host device.

The EPLRS network is organized into a Time Division Multiple Access (TDMA) structure. Each RS in a community is assigned slices of time (called timeslots) in which the RS can transmit while other RSs can receive. To accomplish this, each RS possesses a clock that is synchronized to the clock of every other radio. The system also incorporates internal communications security (COMSEC) devices and has an Over-the-Air-Rekeying (OTAR) capability.

EPLRS radios operate using eight available ultra-high-frequency (UHF) channels at frequencies between 420 to 450 MHz. The radios can presently handle data rates up to 57.6 Kbps and provide x.25, RS-232, and Ethernet interfaces plus the Transmission Control Protocol/Internet Protocol (TCP/IP). Frequency division multiplexing over different channels increases network capacity and minimizes mutual interference. Using the different frequencies, EPLRS can have multiple needlines operating at the same time in the same geographical area. The network can be run in either frequency hopping (for anti-jam purposes) or nonfrequency hopping mode. Additional capabilities that EPLRS provides include:

Four Levels of Relay: Networked communications are possible around and over geographic obstructions and at extended ranges.

Self-healing Net: If a selected networked communication path is unexpectedly interrupted, EPLRS will automatically seek alternative routing, eliminating the necessity of manual intervention by a communication network controller.

Global Positioning System (GPS) Independence: Although EPLRS can use GPS inputs when available, one of the key features of EPLRS is that it does not depend on GPS to provide position and location data, thus avoiding GPS jamming vulnerabilities.

EPLRS NETWORKS

EPLRS allows many users to simultaneously communicate with each other because each RS is programmable and can support multiple concurrent communication networks. The three types of EPLRS networks are listed here. In addition, EPLRS supports ENM-to-RS communications.

Acquisition Network: The acquisition network is used to initially synchronize the RSs to form a network of RSs. It is also used to keep the RSs' time synchronized (in time sync), which keeps the RSs in the network and allows them to communicate with each other.

Coordination Network: The coordination network is used by the RSs to handle network coordination tasks, including relay path coordination for duplex needlines, IP resolution, ENM support, broadcast messaging, and exchange of position location between RSs.

Communication Network: The communication network supports communications between computer systems or hosts. Of the three networks, this is the largest (in terms of available resources) and can be viewed as a wireless internet. Unlike the other networks, the communication network passes data via needlines from external sources (usually host computers connected to the RSs), not from the RSs themselves.

ENM-to-RS Communications: ENM uses the Simple Network Management Protocol (SNMP) residing in the ENM to communicate with individual RSs via an SNMP agent resident in each RS to perform over-the-air network management.

COMMUNICATIONS NEEDLINES

EPLRS uses virtual circuits to set up host-to-host communications between EPLRS RSs. These virtual circuits are called needlines. The needlines can be either point-to-point or broadcast. A single RS can support many needlines at the same time. This capability allows host computers to simultaneously send and receive information from different groups of hosts. There are four types of needlines:

Carrier-Sense Multiple Access (CSMA): CSMA needlines provide many hosts the capability to send data to each other, with user data rates (for the whole needline) from approximately 450 bps to 57,600 bps. A CSMA needline operates like a group of people on a contention voice net, each speaking when he or she has something to say and when no one else is speaking. The RS ensures that no one else is using the needline, so neither the sourcing host nor the user have to bother with the CSMA network access protocol. A CSMA needline lets a large number of users (endpoints) broadcast data to other needline members on demand. CSMA works with a large network and is used to transfer situational awareness and command and control data.

Multi-Source Group (MSG): The MSG needline provides hosts with a few-to-many communication transfer protocol. Messages are transmitted by a select group of source endpoint RSs, and messages are carried on the MSG needline, either directly or through relays, to all other endpoint RSs. MSG needlines provide up to 16 source endpoint RSs, with data rates from about 400 bps to 57,600 bps. An MSG needline operates like a group of people with bullhorns, each person talking in turn to many people who cannot talk back. Some senders may keep their bullhorn (a dedicated resource) whether or not they use it, and others give up their bullhorn (a floating or shared resource) when they are done talking. MSG nets are used for low-latency track data or data exchange.

HDR Duplex: HDR duplex needlines provide hosts with an RS-acknowledged communications transfer protocol that ensures host data are received by the other host. Duplex communications services are point-to-point with each end unit (defined as endpoint) sharing an equal number of transmit opportunities on an alternating basis. An HDR duplex needline operates like talking to another person on a telephone. HDR duplex needlines provide RS-acknowledged, higher reliability, balanced data transfer between two hosts with data rates from approximately 600 bps to 14,400 bps each way. This type of needline is similar to low-data-rate (LDR) duplex needlines, except the user data rate can be much higher.

LDR Duplex: LDR duplex needlines provide a communications transfer protocol that ensures one host's packets are received by the other host. These needlines provide RS-acknowledged high-reliability balanced data transfer between two hosts with data rates from approximately 20 bps to 1920 bps each way.

WARFIGHTER SUPPORT

Currently, EPLRS is being deployed or developed to support the following applications:

Littoral Warfare: Users of the NCS EPLRS in littoral warfare have discovered that this system is ideal for communicating among operating mission elements, Navaid support, and track generation data. Data can be passed securely and seamlessly among mission elements such as airborne relay platforms, shore sites, and afloat sites.

The NCS EPLRS is currently installed aboard LHD 6, with installation planned for LHD 7 and LPD 17 class ships. Figure 2 depicts the EPLRS scenario use during an amphibious assault operation.

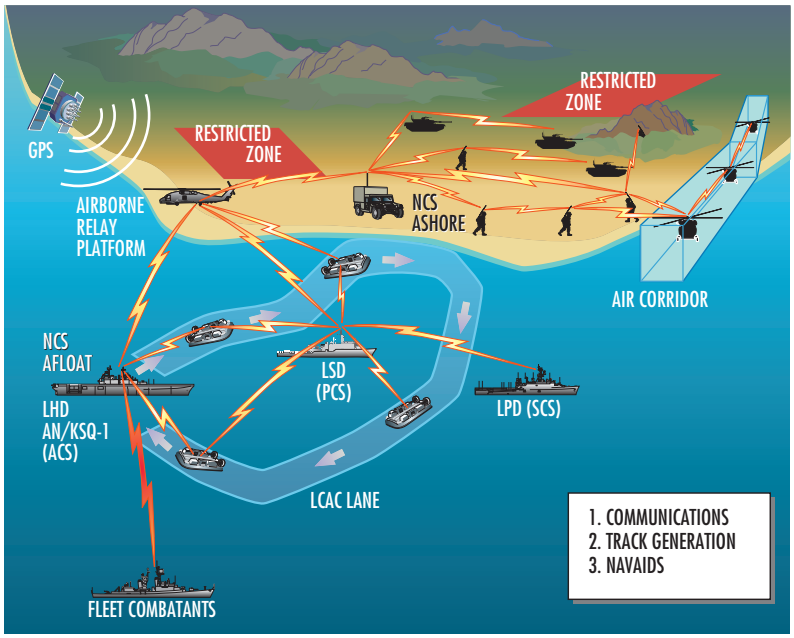


FIGURE 2. EPLRS use in littoral warfare.
Acronyms: ACS – Amphibious Command Ship; PCS – Primary Control Ship; SCS – Secondary Control Ship

Data Exchange in Support of Amphibious Operations: The EPLRS Data Radio (EPLRS-DR) provides secure, variable data rate network communications between shipboard networks and the shore-based Marine Air Ground Task Force (MAGTF) Tactical Data Network in support of Amphibious Task Force tactical operations. Primary data features are speed of service, satisfaction of throughput requirements for priority data users, and reliable data communications. Position location, navigation aids, and friendly identification are key battlefield features. The EPLRS-DR program has adopted EPLRS ENM technology. The system is being introduced to the Fleet. Figure 3 depicts a scenario of EPLRS-DR data-exchange connectivity during an amphibious assault operation.

Battlefield Operations: The Marine Corps and the Army use EPLRS as a data radio that is deployed to serve as the data backbone among military echelons. In the Marine Corps, EPLRS provides data connectivity primarily to the battalion level but also has the capability to extend to the company level. While the EPLRS primary mission is to act as a data link, it also can be used for position location information. Figure 4 depicts how EPLRS is used to support Marine Corps data-exchange connectivity in the battlefield.

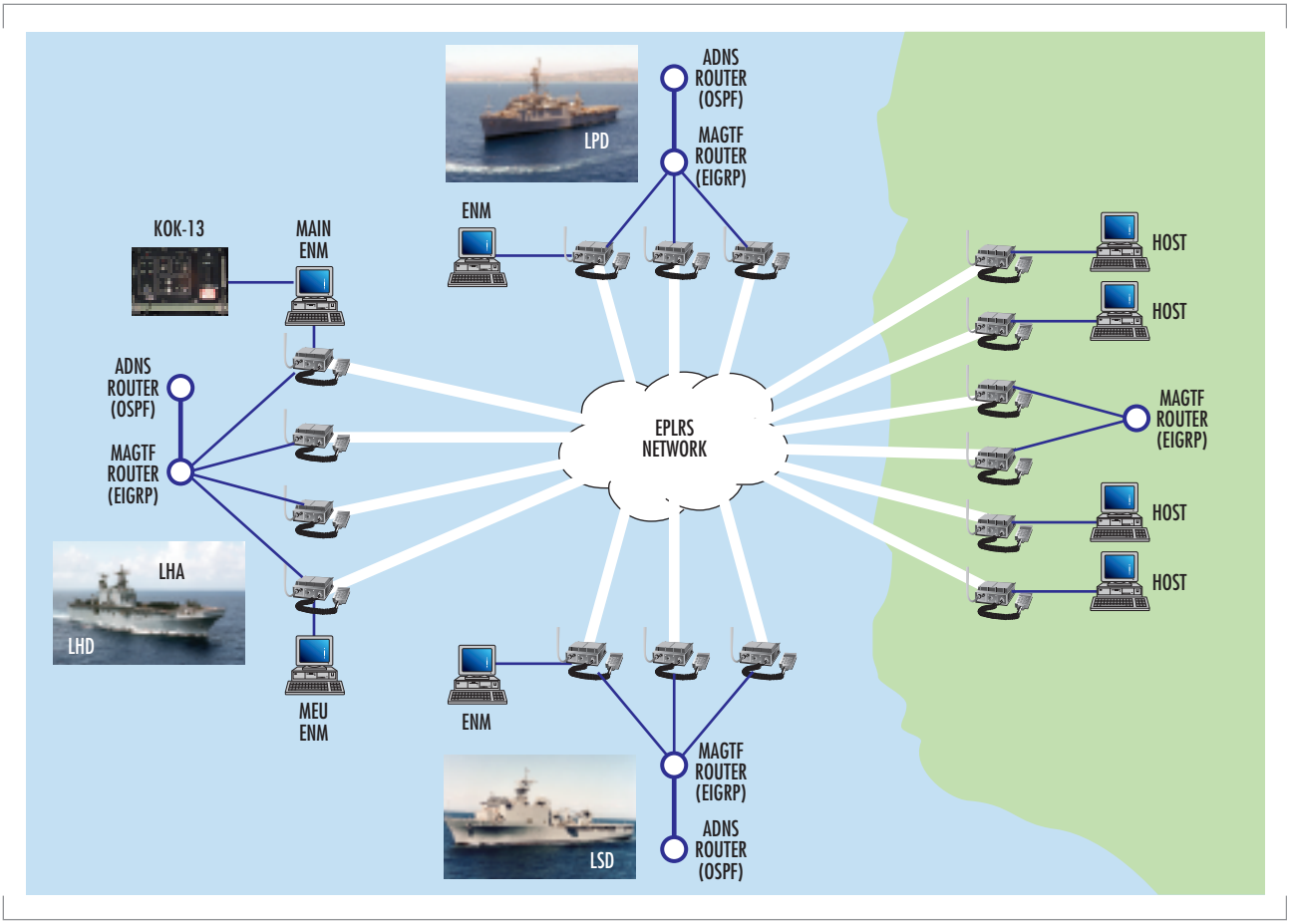


FIGURE 3. EPLRS-DR intra-ATF connectivity.
Acronyms: ADNS – Automatic Digital Network System; ATF – Amphibious Task Force; EIGRP – Enhanced Interior Gateway Routing Protocol; ENM – EPLRS Network Manager; MAGTF – Marine Air-Ground Task Force; MEU – Marine Expeditionary Unit; OSPF – Open Shortest Path First

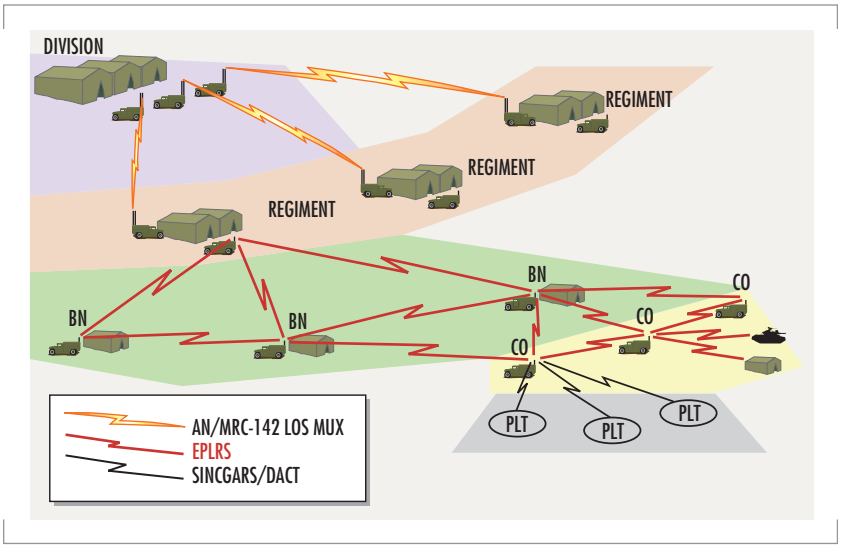
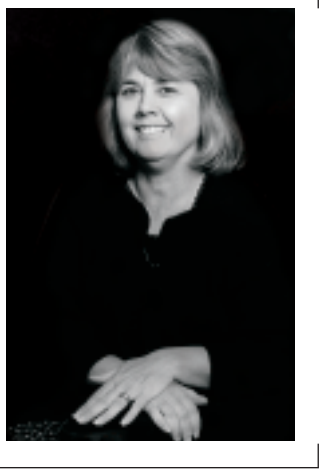


FIGURE 4. EPLRS support for Marine Corps battlefield operations.
Acronyms: BN – Battalion; CO – Company; DACT – Data Automated Communications Terminal; LOS – Line of Sight; MUX – Multiplexer; PLT – Platoon; SINCGARS – Single Channel Ground and Airborne Radio System



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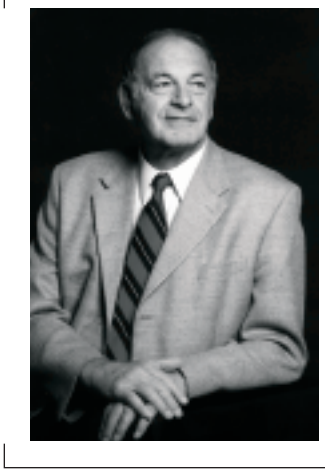

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